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TITLE OF INVENTION CODING APPARATUS AND CODING METHOD OF TIME-VARYING IMAGE SIGNAL					
APPLICANT(S) FOR DO/EO/US Koji IMURA					
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:					
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DESCRIPTION

CODING APPARATUS AND CODING METHOD OF TIME-VARYING IMAGE SIGNAL

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Technical Field

The present invention relates to a coding apparatus and a coding method of digital time-varying image signals for the use of a visual telephone, a video conference, and the like, and more particularly to a coding apparatus and a coding method of digital time-varying image signals in image communication on transmission lines on which transmission errors are generated. The present invention also relates to a decoding apparatus and a decoding method.

Background Art

As a conventional coding method of digital time-varying image signals, there can be cited the coding method in ITU-T (International Telecommunication Union - Telecommunication Standardization Sector) Recommendation H.261 that was recommended in March, 1993. The featured coding method of H.261 is a motion compensation prediction system. The motion compensation prediction system is concretely performed as follows.

First, an input image picture and a pre-coded picture are compared, and a motion quantity between them is

measured (motion detection). An input image picture is predicted on the basis of the motion quantity and the pre-coded picture. The difference between the predicted image (prediction image) and the input image picture
5 (prediction error signal) is calculated, and the prediction error signals and the aforesaid motion quantity are transmitted to a reception side. Thereby, image information can be transmitted in a small data quantity.

10 Moreover, in H.261, there is another method different from the motion compensation picture prediction system. The method does not use the difference between the prediction image and the input image picture, but the method codes the input image picture itself. The method
15 is called as "intra-coding mode". The intra-coding mode is used in a case where any pre-coded pictures exist such as the beginning of communication although the generated data quantity is larger than that in the motion compensation prediction system, and in a case where the
20 correlation between an input image picture and a pre-coded picture is low and the data quantity is larger than that in the motion compensation prediction system.

Moreover, in the case where an transmission error is generated on the transmission lines and a section of
25 images deteriorated, because the deterioration of the picture quality is propagated to the next picture in turn in the motion compensation prediction system in which only

the prediction error signal is transmitted, the deterioration of the picture quality can be recovered by the adoption of the intra-coding.

A picture is divided into blocks (coded blocks), each
5 having 16×16 pixels in both of the motion compensation prediction system and the intra-coding mode, and both the systems are applied at every coded block. A picture in which all of the coded blocks in it are forcedly intra-coded is called as "intra-picture", and a picture
10 coded in conformity with the motion compensation prediction system is called as "inter-picture".

On the other hand, there is a concealing processing technique as a technique for suppressing the deterioration of the picture quality when a transmission
15 error occurs during transmission. The concealing processing technique is the processing to do voluntarily on the side of the reception, and is not included in the contents which are prescribed by the recommendation. However, by performing the processing, the picture
20 quality deterioration in case of the occurrence of the transmission error can be suppressed. As one of the concealing processing techniques, there is a method in which when a transmission error occurred and received coded block data can not be decoded correctly, coded block
25 data existing at the same position in the pre-coded picture is output as it is.

Moreover, as one of the concealing processing

techniques, there is a method in which a motion quantity of a coded block that could correctly be decoded and exists at a peripheral position is adopted as the motion quality of the present coded block and a prediction image is generated from a pre-coded picture by the use of the adopted motion quantity and the generated prediction image is output.

When image communication begins, generally, an intra-picture is used as the first picture. This is because a pre-coded picture that becomes always necessary in case of motion compensation prediction coding does not exist at this time.

When a transmission error occurs during the transmission of the first picture, a coding block of a section of the first picture becomes impossible to be decoded correctly. In this case, because any pre-coded picture does not exist, it is impossible to do the concealing processing using a section of the pre-coded picture. Accordingly, the concealing processing of the section of the first picture cannot help performing by means of a beforehand prescribed value.

As described above, the picture quality when a transmission error occurred in the first picture deteriorates more remarkably than the picture quality when concealing processing is performed in the case where a pre-coded picture exists. Moreover, because the motion compensation prediction system is used, there is a problem

that the deterioration of the picture quality in the first picture is propagated in the second picture and pictures after it with the elapse of time.

5 Disclosure of Invention

An object of the present invention is to provide a coding apparatus and a coding method of a time-varying image signal, both capable of suppressing the remarkable picture quality deterioration at the time of the beginning of communication.

A subject matter of the present invention is that a plurality of pictures are continuously coded in conformity with the intra-coding mode (N times) from the beginning of communication, and that the first (N - 1) pictures are transmitted in rough picture qualities and the last Nth picture is transmitted in a fine picture quality.

Brief Description of Drawings

FIG. 1 is a block diagram showing the configuration of a radio communication apparatus equipped with a coding apparatus according to an embodiment of the present invention;

FIG. 2 is a block diagram showing the configuration of the coding apparatus according to the embodiment of the present invention;

FIG. 3 is a block diagram showing the configuration

of a decoding apparatus corresponding to the coding apparatus according to the embodiment of the present invention; and

FIG. 4 is a frame configuration diagram of a signal to be used in the radio communication apparatus equipped with the coding apparatus of the present invention.

Best Mode for Carrying Out the Invention

Hereinafter, embodiments of the present invention will be described in detail by reference to the attached drawings.

(EMBODIMENT 1)

FIG. 1 is a block diagram showing the configuration of a radio communication apparatus equipped with a coding apparatus according to embodiment 1 of the present invention. Here, the "radio communication apparatus" means a communication terminal apparatus and the like such as a base station apparatus and a mobile station in a digital radio communication system. Moreover, the radio communication apparatus may be a portable terminal and may be configured in a form to be used in a state of being connected with a computer.

In the radio communication apparatus, an image is taken in by an imaging section 101 such as a camera on the transmission side, and is output to an A/D transformer 102 as an image signal. In the A/D transformer 102, the image signal is transformed to a digital sound signal,

and is output to a coding section 103. The coding section 103 performs the image-coding processing of the digital sound signal, and outputs coded information to a modulation/demodulation section 104. The

5 modulation/demodulation section 104 digitally modulates the coded image signal, and transmits the digitally modulated image signal to a radio transmission circuit 105. The radio transmission circuit 105 performs the prescribed radio transmission processing of the modulated
10 signal. The processed signal is transmitted through an antenna 106. Incidentally, a processor 107 performs its processing by using the data stored in a RAM 109 and a ROM 108 appropriately.

On the other hand, on the reception side of the radio
15 communication apparatus, the prescribed radio reception processing of a signal received by the antenna 106 is performed by a radio reception circuit 110, and the processed signal is transmitted to the modulation/demodulation section 104. The

20 modulation/demodulation section 104 performs the demodulation processing of the received signal, and outputs the demodulated signal to the decoding section 111. The decoding section 111 performs the decoding processing of the demodulated signal to obtain a digital
25 decoded signal, and outputs the digital decoded signal to a D/A transformer 112. The D/A transformer 112 transforms the digital decoded signal output from the

decoding section 111 to an analog decoded signal, and outputs the analog decoded signal to a display section 113 such as a display. Finally, the display section 113 displays the image.

5 Here, the coding section 103 and the decoding section 111 is operated by the processor 107 such as a digital signal processor (DSP) by the use of memories stored in the RAM 109 and the ROM 108. Moreover, the programs for these operations are stored in the ROM 108.

10 FIG. 2 is a block diagram showing the configuration of the coding apparatus of the present invention which is applied to the coding section in the radio communication apparatus shown in FIG. 1.

In FIG. 2, a raster/coded block transformation
15 section 201 transforms obtained image data to a raster/coded block. The position information of the raster/coded block transformed by the raster/coded block transformation section 201 is transmitted to a multiplexing section 216. Moreover, the data of the
20 raster/coded block (the present picture) is transmitted to a motion detection section 202.

The motion detection section 202 detects the motion of the image on the basis of the difference between a previous picture and the present picture. In this case,
25 the previous picture is output from a frame memory 203. memory controlling section 204 controls the output of the reproduced image memorized in the frame memory 203 on the

basis of the motion quantity information from the motion detection section 202. Incidentally, the motion quantity information is transmitted to a variable length coding section 215, and is transformed to a Huffman code
 5 there to be transmitted to the multiplexing section 216.

A picture counter 205 counts the number of pictures. The counted value of the picture counter 205 is transmitted to a coding controlling section 206. The coding controlling section 206 judges whether the coding method
 10 of input time-varying image signal is the intra-coding mode or the motion compensation prediction system mode, and then the coding controlling section 206 outputs the judged coding mode to a switch 207. And the coding controlling section 206 controls a quantization parameter
 15 in conformity with the coding mode. This quantization parameter is transmitted to a quantization section 210. Incidentally, the coding mode information is transmitted to the multiplexing section 216.

The coded block data is compared with the previous
 20 picture stored in the frame memory 203 by a subtracter 208 in case of the motion compensation prediction system mode, and the difference is transmitted to a discrete cosine transformation section (DCT) 209. Incidentally, in case of the intra-coding mode, the coded block data
 25 is transmitted to the discrete cosine transformation section 209.

The data that has received the discrete cosine

transformation is transmitted to quantization section 210, and is quantized on the basis of the quantization parameter transmitted from the coding controlling section 206. The quantized data of the DCT coefficient is transmitted to a variable length coding section 211, and is transmitted to an inverse quantization section 212. The variable length coding section 211 transforms the quantized data of the DCT coefficient into a Huffman code, and transmits the Huffman code to the multiplexing section 216.

The quantized data of the DCT coefficient transmitted to the inverse quantization section 212 is inversely quantized and becomes a DCT coefficient to be transmitted to an inverse discrete cosine transformation section 213. The inverse discrete cosine transformation section 213 performs the inverse discrete cosine transformation by the use of the DCT coefficient to obtain coded block data corresponding to the difference between the previous picture and the current picture.

An adder 214 obtains the present picture by adding the coded block data and the previous picture, that is, by updating the previous picture in its moved parts. The obtained present picture is transmitted to the frame memory 203 and is stored therein.

The multiplexing section 216 multiplexes the DCT coefficient, the motion quantity information, the position information of the coded block, and the coded mode to obtain multiplexed data. The multiplexed data is

transmitted.

Next, the operations of the coding apparatus having the aforesaid configuration will be described.

An input image is divided into coded blocks in a size of, for example, 16×16 pixels in the raster/coded block transformation section 201 to be output therefrom. Next, the divided coded block data is transmitted to the motion detection section 202, and is compared with a previous picture in the frame memory 203 therein. Then, the motion quantity of the present coded block (the difference between the previous picture and the present picture) is obtained. The motion quantity information is transmitted to the variable length coding section 215, and is transformed to a Huffman code therein to be transmitted to the multiplexing section 216.

The picture counter 205 counts and outputs the number of pictures which were input from the communication beginning time. The information of the image which was beforehand selected (the coding image choice information) by a (not shown) processing section for selecting an image to be coded is input into the picture counter 205. The picture counter 205 increases its counting value at every inputting of the image information. Moreover, the picture counter 205 is configured so that the picture counter 205 is automatically reset when the power source of the apparatus is turned on or at the initial time of image transmission.

The switch 207 switches the output of the picture from the frame memory 203 on the basis of the information of the coding mode of the coding controlling section 206. To put it concretely, in case of the intra-coding mode, the switch 207 is switched to the side of "0". And, in case of the motion compensation prediction system, the switch 207 is switched to the frame memory 203 to make the frame memory 203 output the data of the previous picture to the subtracter 208.

The subtracter 208 obtains the difference between the previous picture and the present coded block data to output the obtained difference value to the discrete cosine transformation section 209. In the discrete cosine transformation section 209, the difference value is changed into a frequency domain, and it becomes a DCT coefficient to be transmitted to the quantization section 210. In the quantization section 210, the DCT coefficient is quantized to be transmitted to the variable length coding section 211 as a quantized data. In the variable length coding section 211, the quantized data is transformed to a Huffman code. Incidentally, in case of the intra-coding mode, the difference value becomes the coded block data as it is, and, in case of the motion compensation prediction system, the difference value becomes a motion prediction error signal.

The DCT coefficient of the quantized frequency domain is restructured to the original difference value

in the inverse quantization section 212 and in the inverse discrete cosine transformation section 213, and the restructured difference value is added to the previous picture from the frame memory 203 and is written in the frame memory 203 for the use of the coding the next picture.

The coding block data transformed to the Huffman code, the DCT coefficient, the motion quantity information, the coded block position information and the coding mode are multiplexed to be one data in the multiplexing section 216 to be output. For example, in a multiplex data, as shown in FIG. 4, the coded block position information 402 is arranged between a start code 401 and a header 403, and coding mode information 404, motion quantity information 405 and a coefficient of the cosine transformation 406 are arranged following the header 403.

The coding apparatus of the present invention surely transmits the first image, which is used as a reference image, by transmitting the same image at a plurality of times at the beginning of communication or the initial time of the transmission of an image by the use of the aforesaid picture counter. Thereby, the processing of the flowing steps, i.e. the processing of updating the reference image by the difference from the reference image, is made to be sure. As a result, it is possible to make the deterioration of picture quality degradation on the image reception side reduce.

Next, a transmission control by the picture counter

will be described.

The coding controlling section 206 outputs quantization mode information for controlling the coding apparatus of the present invention to perform the
5 intra-coding to the quantization section 210 when the counted value from the picture counter 205 is equal to or less than a predetermined value (N). In this case, because the switch 207 is switched to the "0" side in conformity with an instruction from the coding
10 controlling section 206, the quantization section 210 performs the quantization of the DCT coefficient about the intra-picture.

Moreover, when the counted value of the picture counter 205 is larger than N, the coding controlling
15 section 206 outputs the coding mode information for controlling the coding apparatus to perform the coding in conformity with the motion compensation prediction system to the quantization section 210. In this case, because the switch 207 is switched to the frame memory
20 203 side in conformity with the instruction from the coding controlling section 206, the quantization section 210 performs the quantization of a DCT coefficient about an inter-picture.

Moreover, the coding controlling section 206 outputs
25 to the quantization section 210 a signal for controlling the coding apparatus so that the value of quantization parameter is large, namely the image is rough, when the

counted value is equal to or less than $(N - 1)$, and that the value of the quantization parameter is small, namely the image is fine, when the counted value is N .

For example, in case of N is three, namely in the
 5 case where the number of times of the plural transmission is three, examples of the coding mode and the quantization parameter in each picture are shown in the following.

1st picture: Intra-coding mode, Quantization
 10 parameter = 31
 2nd picture: Intra-coding mode, Quantization
 parameter = 31
 3rd picture: Intra-coding mode, Quantization
 parameter = 8
 15 4th picture and the following: Motion compensation
 prediction system quantization, Parameter is arbitrary.
 (Smaller quantization parameters indicate finer
 images.)

20 The picture quality and the number of times of
 transmission of the image which are transmitted at a
 plurality of times can be determined under the
 consideration of the certainty of the transmission
 thereof and the data quantity thereof. In consideration
 25 of these points, it is preferable that the number of times
 of transmission is three and only the final image is made
 to be fine.

When the difficulty of the occurrence of errors in the case where the number of times of transmission is three is calculated, the result becomes as follows. As the preconditions, the following conditions are supposed.

- 5 Transmission error rate: $1e-4$ (Error of one bit occurs at every 10,000 bits on an average),
 Code quantity of a fine picture quality: 16,000 bits,
 Code quantity of a rough picture quality: 6,400 bits.

- 10 When the first and the second pictures are coded roughly and the third picture is coded finely, the code quantity of each picture becomes the following.

- Code quantity of the first picture: 6,400 bits,
 Code quantity of the second picture: 6,400 bits,
 15 Code quantity of the third picture: 16,000 bits.

- In this case, if the transmission error rate is $1e-4$, the probability of the occurrence of a transmission error in the first picture is $6,400 \text{ bits} \times 1e-4 = 0.64$. Moreover,
 20 if the number of the transmission units (the unit of the transmission in the case where a screen is divided into narrow strips) is nine, the probability that an error is generated in any one of the nine transmission units is
 $6,400 \text{ bits} \times 1e-4 \times 1/9 = 0.07$ when nine transmission units
 25 have the same probability that an error is generated in each unit.

 Similarly, as for the second picture, too, the

probability is $6,400 \text{ bits} \times 1e-4 \times 1/9 = 0.07$. As for the third picture, because the code quantity thereof is 16,000 bits, the probability is $16,000 \text{ bits} \times 1e-4 \times 1/9 = 0.18$.

The probability that errors are generated in the same
5 transmission unit among the nine transmission units at
all of three times of transmission is

$$0.07 \times 0.07 \times 0.18 = 0.008.$$

Because, in the conventional coding apparatus, only
the first picture is the picture in conformity with the
10 intra-coding mode and the second and following pictures
are pictures in conformity with the motion compensation
prediction system, the probability that the reference
image becomes impossible to be used (the probability that
a coded block cannot be decoded owing to a transmission
15 error) is 0.18. Therefore, the embodiment of the present
invention can decrease the probability that it becomes
impossible to use the reference image by about 95 %.

Incidentally, as for the code quantity, the ratio
of the intra-coding mode (Ia) code quantity (fine), the
20 intra-coding mode (Ib) code quantity (rough) and the
motion compensation prediction system (P) code quantity
is about 7 : 3 : 1, the code quantities from the beginning
of communication through the fourth 4 picture are the
following in comparison with the prior art:

25 I P P P = 7, 1, 1, 1 = 9 (in the prior art),

Ib Ib Ia P = 3, 3, 7, 1 = 14 (in the present invention).

Then, the increased quantity of the present invention is

one and a half times.

Under the consideration of the increased code quantity and the probability that the first picture becomes impossible to be used like that, the number of
5 times of transmission and the picture quality and so on can be determined. Because the generated code quantity depends on input images, these number of times of transmission and the picture quality are appropriately changed.

10 In the coding apparatus of the present invention, a plurality of pictures are coded in conformity with the intra-coding mode successively (N times) from the beginning of communication, and first (N - 1) pictures are transmitted in rough picture qualities, and further
15 the last Nth picture is transmitted in a fine picture quality.

According to the present invention, the probability that a coded block at the same position becomes impossible to be correctly decoded even once can be decreased, and
20 the propagation of the deterioration of picture quality is prevented, by transmitting an intra-picture (N-1) times successively. Consequently, if there is a coded block that could not correctly be decoded owing to the occurrence of a transmission error in the first picture,
25 because the next picture is transmitted in a state of being coded in conformity with the intra-coding, it becomes possible to recover the coded block from being

deteriorated in its picture quality unless the coded block at the same position in the next picture can correctly be decoded owing to a transmission error.

In this case, because the intra-picture has a code
 5 quantity larger than that of the inter-picture in conformity with the motion compensation prediction coding system, the coding apparatus of the embodiment takes a lot of time necessary for the transmission from the side of transmission to the side of reception. Accordingly the
 10 coding apparatus suppresses the code quantity by transmitting the first (N-1) pictures in rough picture quality for shortening the transmission time. Moreover, it becomes possible to decrease the probability that a transmission error is generated in the (N - 1) pictures
 15 by making the picture qualities of the (N - 1) pictures rough to decrease the code quantity.

(EMBODIMENT 2)

FIG. 3 is a block diagram showing the configuration of a decoding apparatus corresponding to the coding
 20 apparatus according to the embodiment 1.

In FIG. 3, a received signal is transmitted to a separation section 301 to be separated there to a Huffman code of a DCT coefficient, a Huffman code of motion quantity information, coded block position information,
 25 and coding mode information. The separated codes and information are transmitted to respective processing sections. To put it concretely, the DCT coefficient is

transmitted to a variable length decoding section 302; the motion quantity information is transmitted to a variable length decoding section 305; the coded block position information is transmitted to a frame memory 307 and a decoding error memory 310; and the coding mode information is transmitted to an intra-transmission requirement judging section 309.

The DCT coefficient that was coded by the variable length decoding section 302 is transmitted to an inverse quantization section 303 to be quantized inversely. The DCT coefficient which was quantized inversely is transmitted to an inverse discrete cosine transformation section 304, and is used for the inverse discrete cosine transformation there.

The motion quantity information that was decoded by the variable length decoding section 305 is transmitted to a memory controlling section 306. The memory controlling section 306 controls a picture output from the frame memory 307. Incidentally, when a decoding error is generated in the variable length decoding sections 302, 305, a decoding error signal is transmitted to the decoding error memory 310.

The intra-transmission requirement judging section 309 judges whether an intra-transmission requirement is necessary or not on the basis of whether the picture in which a decoding error was generated is an intra-picture or not, namely whether a coded block that was not correctly

decoded even once in conformity with the intra-coding mode exists or not, and transmits an intra-transmission requirement signal to a communication companion.

In the decoding apparatus, the position of a coded
 5 block that could not correctly decoded owing to a transmission error among intra-pictures received from the beginning of communication is memorized in the memory. In the case where a coded block that could not correctly decoded in conformity with the intra-coding mode when an
 10 inter-picture is first received from the beginning of the communication, the decoding apparatus is controlled to output an intra-picture transmission requirement to the transmission side. To put it concretely, the decoding apparatus judges whether a coded block that could not be
 15 decoded correctly exists or not by reference to the memory at the time of detecting an inter-picture first, and judges whether the decoding apparatus outputs an intra-picture transmission requirement to the transmission side.

This is due to the following reason. That is, in the
 20 case where the coded block that could not correctly decoded in conformity with the intra-coding mode even once at the time of the reception of an inter-picture, no image data is written in the coding block. Consequently, the picture quality of the coded block is remarkably deteriorated.
 25 When the inter-picture is received in spite of the existence of such a coded block, the deterioration of the picture quality is propagated and unseemly images are kept

on being output.

Accordingly, the position of a coded block that could not correctly decoded from the beginning of communication in conformity with the intra-coding mode even once is stored. And if the coded block that could not correctly be decoded in conformity with the inter-coding mode even once exists when the first inter-picture is received after the beginning of the communication, the decoding apparatus does not decode the inter-picture, and requires an intra-picture to the transmission side. Thereby, an intra-picture having no coded block that could not correctly be decoded in conformity with the intra-coding mode can be obtained, and then the reference to the coded block that could not be decoded in conformity with the intra-coding mode even once by the inter-picture is obviated. Thereby, the timewise propagation of the remarkable deterioration of picture quality can be avoided.

Next, the operations of the decoding apparatus having the aforesaid configuration will be described.

First, the data transmitted from the transmission side is separated to a Huffman code of a DCT coefficient, a Huffman code of motion quantity information, coded block position information and a coding mode information by the separation section 301.

The Huffman code of the DCT coefficient is decoded to a DCT coefficient after quantization by the variable

length decoding section 302, and is inversely quantized to the DCT coefficient by the inverse quantization section 303. The DCT coefficient which was inversely quantized is transmitted to the inverse discrete cosine transformation section 304, and is used for the inverse discrete cosine transformation there, and then an image data is obtained.

The Huffman code of the motion quantity information, too, is similarly decoded to the motion quantity information by the variable length decoding section 305, and is transmitted to the memory controlling section 306. The memory controlling section 306 calculates an address for reading image data from the frame memory 307 on the basis of the motion quantity information.

An output of the frame memory 307 and image data after the inverse discrete cosine transformation are added to each other by the adder 308, and a reproduced image is reproduced. The reproduced image is output and memorized in the frame memory 307 to be used for the decoding of the next picture.

The variable length decoding sections 302, 305 severally output a decoding error signal when they detect a code that does not exist as a variable length code owing to a transmission error during decoding. The decoding error memory 310 memorizes the coded block that could not correctly be decoded at every coded block.

The decoding error memory 310 is initialized at a

value which is not zero and one, and the value zero is written in the memory 310 to a coded block that was correctly decoded, and the value of one is written in the memory 310 to a coded block in which a decoding error occurred. To a coded block that was once written as zero, the decoding error memory 310 is controlled so as not to write one in it even if a decoding error is generated in the coded block. That is, when a decoding error is generated, the error state of the coded block is read out from the decoding error memory 310. If the error state is zero, the contents of the decoding error memory 310 are not updated. If the error state is the initial value, value one is written in, and if the error state is one, the error state is left as it is.

By such controlling, it becomes possible that a coded block that could correctly be decoded even once in conformity with the intra-coding mode is not memorized in the decoding error memory 310 even if the coded block cannot correctly be decoded after that.

The intra-transmission requirement judging section 309 receives the separated coding mode information, and refers to the decoding error memory 310 when the section 309 receives a first inter-picture after the beginning of reception. When a coded block that could not correctly be decoded even once exist in the decoding error memory 310 even if the coding mode is the intra-coding mode, the section 309 outputs an intra-transmission requirement

signal to the transmission side (the side of the communication companion).

Incidentally, if a concealing processing function is provided on the decoding side, because a pre-coded picture for performing the concealing processing already exists and the probability that a coded block at the same position cannot correctly decoded for $(N - 1)$ times successively is very low even if a transmission error is generated at the time of receiving the Nth picture, the avoidance of the remarkable deterioration of picture quality becomes possible.

By the execution of such control, an intra-picture that has no coded block that could not correctly decoded in conformity with the intra-coding mode even once can be obtained, the reference to the coded block that could not correctly be decoded in conformity with the intra-coding mode even once by the inter-picture is obviated, and thereby the timewise propagation of the remarkable deterioration of picture quality can be avoided.

The interactive image communication becomes possible by the configuration providing the aforesaid coding apparatus and the decoding apparatus of the present invention and by the use of the configuration on both of the transmission side and the reception side.

Incidentally, although the time-varying image coding/decoding according to the aforesaid embodiments

1, 2 are described as the time-varying image coding apparatus/the time-varying image decoding apparatus, these time-varying image coding/decoding may be configured as software. For example, the coding apparatus and the decoding apparatus may be configured so that time-varying image coding/decoding programs are stored in a ROM and the time-varying image coding/decoding are executed in conformity with the program by instructions of CPU. Moreover, the software may be read out from a medium storing the software, and the time-varying image coding/decoding may be executed by a computer. In such a case, too, the same operations and effects as those in the embodiments 1, 2 are developed.

Although a case using radio transmission lines that is easy to generate an error during transmission is described, the present invention may also be applied to a case using wire transmission lines. The present invention especially develops its effects in radio image communication terminals.

The coding apparatus of the present invention has a configuration comprising an intra-coding section for performing the intra-coding in which coded blocks formed by the division of a time-varying image signal to a plurality of blocks are coded as they are, and a coding controlling section for performing the control of coding so that the successive intra-coding of N pictures are performed from the beginning of communication.

According to the configuration, the probability that a coded block at the same position becomes impossible to be correctly decoded even once can be decreased by the successive transmission of an intra-picture (N-1) times, and the propagation of the deterioration of picture quality is obviated. Consequently, even if a transmission error is generated in the first picture and a coded block that could not correctly be decoded exists, because the next picture is transmitted after the intra-coding thereof, it becomes possible to recover the coded block from being deteriorated in its picture quality unless the coded block at the same position in the next picture can correctly be decoded owing to a transmission error.

The coding apparatus of the present invention has a configuration in which the coding controlling section makes the picture qualities of (N - 1) pictures from the beginning of communication relatively rough and makes the picture quality of the Nth picture from the beginning of the communication relatively fine.

According to the configuration, a code quantity can be suppressed to be small, and transmission time can be shortened. Thereby, the probability of the occurrence of a transmission error in a picture can be decreased.

A decoding apparatus of the present invention has a configuration comprising: a decoding section for decoding an image-coded data; a memorizing section for

memorizing position information of a coded block in a time-varying image signal, the coded block corresponding to an image-coded data that could not correctly be decoded owing to a transmission error, in a case where the

5 image-coded data is an image-coded data after performing of intra-coding thereof; and a requiring section for ascertaining whether a coded block that could not correctly be decoded even once exists in the memorizing section or not when a first image-coded data after

10 performing of motion compensation prediction coding thereof from a beginning of communication, and for requiring transmission of a picture after performing of intra-coding thereof when existence of the coded block, which has not been decoded correctly, is ascertained.

15 According to the configuration, an intra-picture which does not have the coding block which could not correctly be decoded in conformity with the intra-coding mode even once can be obtained, and the timewise propagation of the remarkable deterioration of image

20 quality can be obviated.

The decoding apparatus of the present invention has a constitution in which the decoding section does not perform decoding of the image-coded data after performing of the motion compensation prediction coding thereof in

25 a case where the coded block that could not correctly be coded even once exists in the memorizing section when the first image-coded data after performing of the motion

compensation prediction coding from the beginning of the communication.

According to the configuration, the reference to the coded block which could not correctly be decoded even once
 5 in conformity with the intra-coding mode by an inter-picture is obviated, and thereby the timewise propagation of the remarkable deterioration of a picture quality can be avoided.

A coding method of the present invention comprises:
 10 an intra-coding step for performing intra-coding in which coded blocks formed by division of a time-varying image signal to a plurality of blocks are coded as they are; and a coding controlling step for performing control of coding so that successive intra-coding of N pictures is
 15 performed from a beginning of communication, and for making picture qualities of (N - 1) pictures from the beginning of the communication relatively rough, and further for making a quality of a Nth picture from the beginning of the communication relatively fine.

20 According to the method, the probability that a coded block at the same position becomes impossible to be correctly decoded even once can be decreased, and the propagation of the deterioration of picture quality is prevented, by transmitting an intra-picture (N-1) times
 25 successively. Consequently, if there is a coded block that could not correctly be decoded owing to the occurrence of a transmission error in the first picture, because the

next picture is transmitted in a state of being coded in conformity with the intra-coding, it becomes possible to recover the coded block from being deteriorated in its picture quality unless the coded block at the same position
5 in the next picture can correctly be decoded owing to a transmission error.

A decoding method of the present invention comprises: a decoding step for decoding an image-coded data; a memorizing step for memorizing position
10 information of a coded block in a time-varying image signal, the coded block corresponding to an image-coded data that could not correctly be decoded owing to a transmission error, in a case where the image-coded data is an image-coded data after performing of intra-coding
15 thereof; and a requiring step for ascertaining whether a coded block that could not correctly be decoded even once exists or not when a first image-coded data after performing of motion compensation prediction coding thereof from a beginning of communication is received,
20 and for requiring transmission of a picture after performing of intra-coding thereof when existence of the coded block, which has not been decoded correctly, is ascertained.

According to the method, an intra-picture having no
25 coded block that could not correctly be decoded even once in conformity with the intra-coding mode can be obtained, and thereby the timewise propagation of the remarkable

deterioration of picture quality can be avoided.

In the decoding step, the decoding method of the present invention does not perform decoding of the image-coded data after performing of the motion compensation prediction coding thereof in a case where the coded block that could not correctly be coded even once exists when the first image-coded data after performing of the motion compensation prediction coding from the beginning of the communication is received.

According to the method, the reference to the coded block which could not correctly be decoded even once in conformity with the intra-coding mode by an inter-picture is obviated, and thereby the timewise propagation of the remarkable deterioration of picture quality can be avoided.

As described above, according to the present invention, the probability that a coded block at the same position becomes impossible to be correctly decoded in conformity with the intra-coding mode even once can be suppressed to be low, and the timewise propagation of the remarkable deterioration of picture quality is obviated. Consequently, it becomes possible to provide an image easy to see even if image transmission using transmission lines on which transmission errors are generated is performed.

Moreover, in the case where there are coded blocks at the same position that could not correctly be decoded in conformity with the intra-coding mode even once, the

present invention does not perform the decoding of an inter-picture. Consequently, the remarkable deterioration of picture quality is avoided and the timewise propagation of the deterioration is obviated.

5 Thereby an image easy to see can be provided.

 This application is based on the Japanese Patent Application No. HEI 11-213808 filed on July 28, 1999, entire content of which is expressly incorporated by

10 reference herein.

Industrial Applicability

 The present invention can be applied to an communication terminal apparatus such as a base station

15 apparatus and a mobile station in a digital radio communications system.

CLAIMS

1. A coding apparatus of a time-varying image signal,
said apparatus comprising:

intra-coding means for performing intra-coding in
5 which coded block formed by division of a time-varying
image signal to a plurality of blocks are coded as they
are; and

coding controlling means for performing control of
coding so that successive intra-coding of N pictures are
10 performed from a beginning of communication.

2. The coding apparatus of a time-varying image
signal according to claim 1, wherein said coding
controlling means makes picture qualities of (N - 1)
pictures from the beginning of communication relatively
15 rough and makes a picture quality of a Nth picture from
the beginning of the communication relatively fine.

3. A base station apparatus including a coding
apparatus of a time-varying image signal, said coding
apparatus comprising:

20 intra-coding means for performing intra-coding in
which coded block formed by division of a time-varying
image signal to a plurality of blocks are coded as they
are; and

coding controlling means for performing control of
25 coding so that successive intra-coding of N pictures are
performed from a beginning of communication.

4. A communication terminal apparatus including a

coding apparatus of a time-varying image signal, said coding apparatus comprising:

intra-coding means for performing intra-coding in which coded block formed by division of a time-varying image signal to a plurality of blocks are coded as they are; and

coding controlling means for performing control of coding so that successive intra-coding of N pictures are performed from a beginning of communication.

10 5. A decoding apparatus of a time-varying image signal, said apparatus comprising:

decoding means for decoding an image-coded data;

memorizing means for memorizing position information of a coded block in a time-varying image signal, the coded block corresponding to an image-coded data that could not correctly be decoded owing to a transmission error, in a case where said image-coded data is an image-coded data after performing of intra-coding thereof; and

20 requiring means for ascertaining whether a coded block that could not correctly be decoded even once exists in said memorizing means or not when a first image-coded data after performing of motion compensation prediction coding thereof from a beginning of communication is received, and for requiring transmission of a picture after performing of intra-coding thereof when existence of the coded block, which has not been decoded correctly,

is ascertained.

6. The decoding apparatus of a time-varying image signal according to claim 5, wherein said decoding means does not perform decoding of the image-coded data after performing of the motion compensation prediction coding thereof in a case where the coded block that could not correctly be coded even once exists in said memorizing means when the first image-coded data after performing of the motion compensation prediction coding from the beginning of the communication is received.

7. A base station apparatus including a decoding apparatus of a time-varying image signal, said decoding apparatus comprising:

decoding means for decoding an image-coded data;
15 memorizing means for memorizing position information of a coded block in a time-varying image signal, the coded block corresponding to an image-coded data that could not correctly be decoded owing to a transmission error, in a case where said image-coded data is an
20 image-coded data after performing of intra-coding thereof; and

requiring means for ascertaining whether a coded block that could not correctly be decoded even once exists in said memorizing means or not when a first image-coded
25 data after performing of motion compensation prediction coding thereof from a beginning of communication is received, and for requiring transmission of a picture

after performing of intra-coding thereof when existence of the coded block, which has not been decoded correctly, is ascertained.

8. A communication terminal apparatus including a decoding apparatus of a time-varying image signal, said decoding apparatus comprising:

decoding means for decoding an image-coded data;

memorizing means for memorizing position information of a coded block in a time-varying image signal, the coded block corresponding to an image-coded data that could not correctly be decoded owing to a transmission error, in a case where said image-coded data is an image-coded data after performing of intra-coding thereof; and

requiring means for ascertaining whether a coded block that could not correctly be decoded even once exists in said memorizing means or not when a first image-coded data after performing of motion compensation prediction coding thereof from a beginning of communication is received, and for requiring transmission of a picture after performing of intra-coding thereof when existence of the coded block, which has not been decoded correctly, is ascertained.

9. A coding method of a time-varying image signal, said coding method comprising:

an intra-coding step for performing intra-coding in which coded blocks formed by division of a time-varying

image signal to a plurality of blocks are coded as they are; and

a coding controlling step for performing control of coding so that successive intra-coding of N pictures is performed from a beginning of communication, and for making picture qualities of $(N - 1)$ pictures from the beginning of the communication relatively rough, and further for making a quality of a N th picture from the beginning of the communication relatively fine.

10 10. A decoding method of a time-varying image signal, said method comprising:

a decoding step for decoding an image-coded data;
a memorizing step for memorizing position information of a coded block in a time-varying image signal,
15 the coded block corresponding to an image-coded data that could not correctly be decoded owing to a transmission error, in a case where said image-coded data is an image-coded data after performing of intra-coding thereof; and

20 a requiring step for ascertaining whether a coded block that could not correctly be decoded even once exists or not when a first image-coded data after performing of motion compensation prediction coding thereof from a beginning of communication is received, and for requiring
25 transmission of a picture after performing of intra-coding thereof when existence of the coded block, which has not been decoded correctly, is ascertained.

11. The decoding method of a time-varying image signal according to claim 10, wherein in said decoding step, decoding of the image-coded data after performing of the motion compensation prediction coding thereof is
5 not performed in a case where the coded block that could not correctly be coded even once exists when the first image-coded data after performing of the motion compensation prediction coding from the beginning of the communication is received.

ABSTRACT

A picture counter 205 counts and outputs the number of pictures input from the beginning of communication. A coding controlling section 206 outputs coding mode
5 information for controlling a coding apparatus to perform intra-coding when a counted value of the picture counter 205 is equal to or less than a predetermined value (N), and outputs coding mode information for motion compensation prediction system when the counted value is
10 more than N. Moreover, when the counted value is equal to and less than (N-1), the coding controlling section 206 outputs a signal for controlling a quantization section 210 to make the value of a quantization parameter large to the quantization section 210, and when the counted
15 value is N, the coding controlling section 206 outputs a signal for controlling the quantization section 210 to make the quantization parameter small to the quantization section 210. A switch 207 is switched to "0" in case of the intra-coding and is switched to a frame memory 203
20 in case of the compensation prediction system in conformity with a signal of the coding controlling section 206.

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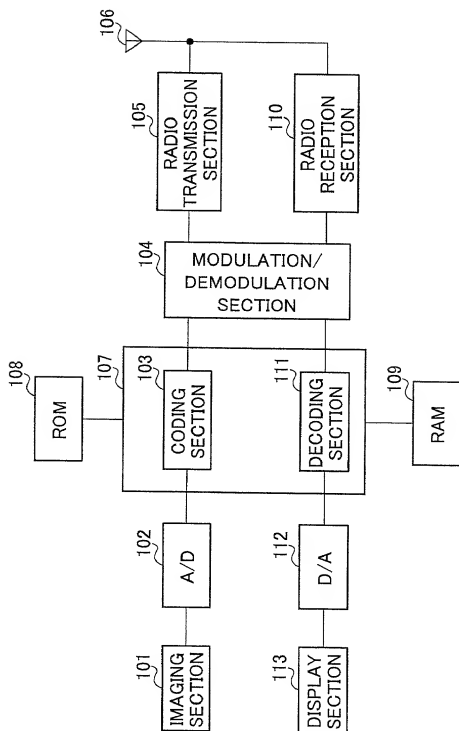


FIG. 1

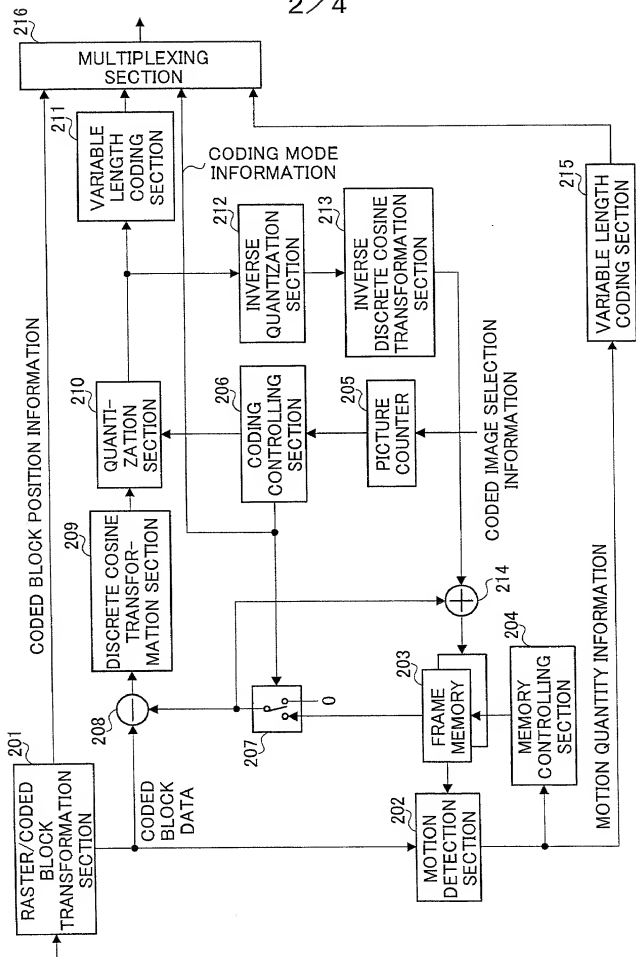


FIG. 2

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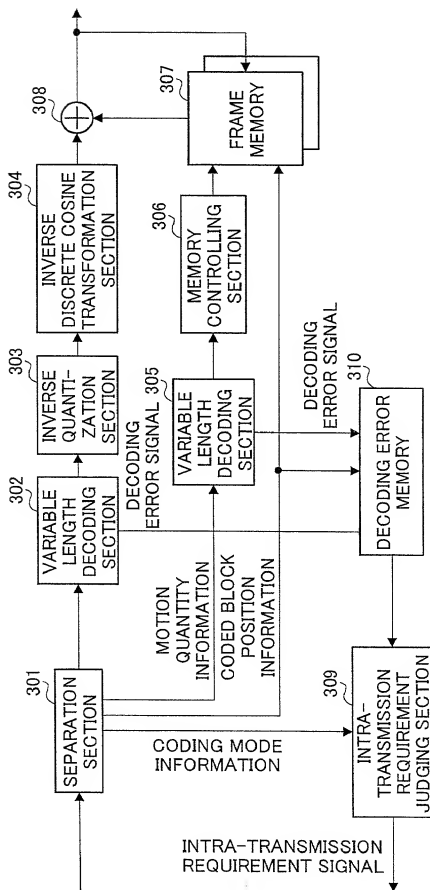


FIG. 3

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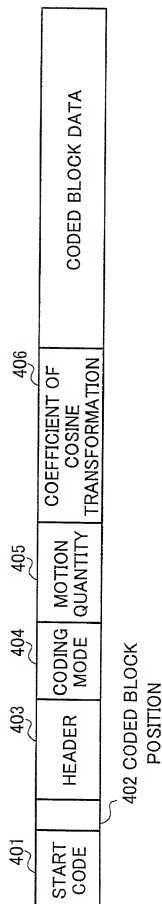


FIG. 4

APPLICATION FOR UNITED STATES PATENT
Declaration for Patent Application

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on

the invention entitled: CODING APPARATUS AND CODING METHOD OF TIME-VARYING IMAGE SIGNAL

the specification of which _____ 2 (file no _____)

(check at least one) 3 ☒ [x] is attached hereto
4 ☐ [] was filed on _____ as (5) U.S. Application Serial No. _____
6 ☐ [] and was amended _____
(if applicable)

Use this portion only if you are entering the U.S. National phase based on a PCT International Application designating the U.S.	7 <input checked="" type="checkbox"/> [x]	was filed as PCT international application		
	8	Number	<u>PCT/JP00/04568</u>	
	9	on	<u>July 10, 2000</u>	
	10	and was amended under PCT Article(s) 19 and/or 34	_____ (if applicable).	
	11	priority date claimed in PCT International Application	_____	
		<u>JAPAN</u>	<u>JP11-213808</u>	<u>28/July/1999</u>
		(Country)	(Number)	(Day/Month/Year Filed)
		_____	_____	_____
		(Country)	(Number)	(Day/Month/Year Filed)
		_____	_____	_____
		(Country)	(Number)	(Day/Month/Year Filed)

I hereby declare that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended, by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me which is material to patentability in accordance with Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date earlier than that of the application(s) on which priority is claimed.

Prior (Foreign) Application(s) any Priority Claims Under 35 U.S.C. §119				Priority Claimed	
_____	_____	_____	<input type="checkbox"/> []	<input type="checkbox"/> []	
(Country)	(Number)	(Day/Month/Year Filed)	Yes	No	
_____	_____	_____	<input type="checkbox"/> []	<input type="checkbox"/> []	
(Country)	(Number)	(Day/Month/Year Filed)	Yes	No	

Priority Claim(s) from U.S. Provisional Application(s) – I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below:

12b	Application No.	Day/Month/Year Filed	Application No.	Day/Month/Year Filed
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Do not use this portion to identify a PCT application if the parent application is the U.S. National phase of the PCT application	I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between filing date of the prior application and the national or PCT international filing date of this application.		
	13	_____	_____
	(U.S. Application Number)	(U.S. Filing Date)	Status (patented, pending, abandoned)

I hereby appoint the following attorneys of the firm of Stevens, Davis, Miller & Mosher, L.L.P. as my attorneys of record with full power of substitution and revocation to prosecute this application and to transact all business in the Patent and Trademark Office:

James E. Ledbetter, Reg. No. 28732; Thomas P. Pavelko, Reg. No. 31689; and Anthony P. Venturino, Reg. No. 31674.

ALL CORRESPONDENCE IN CONNECTION WITH THIS APPLICATION SHOULD BE SENT TO
STEVENS, DAVIS, MILLER & MOSHER, L.L.P., 1615 L Street, N.W., Suite 850, Washington, D.C. 20036,
TELEPHONE (202) 408-5100, FACSIMILE (202) 408-5200.

See page 2 for signature lines

INSTRUCTIONS FOR COMPLETION OF THIS FORM

Insert the same title as is used on the specification and in the assignment.

is optional but is provided so that you can use it to identify more readily an application prior to the time that the Patent Office application serial number is issued. We suggest that the specification, drawings and declaration always bear a file number since it can help to get the papers together in case they become inadvertently lost. In instances where the specification is filed without a signed declaration form (under 37 CFR §1.53) a file number on a later-received separate form will assist us in associating it with the correct case.

line 3 Check this box if the specification, claims and drawing (if any) are attached to this declaration form, e.g., when filing a new patent application.

lines 4-5 Are only used in an instance where the application is already on file and the declaration form is being separately filed, e.g., when the application was originally filed without a signed declaration or where the Patent Office has required a new declaration because of a deficiency in the original declaration. In such an instance the Patent Office will require that lines 4 and 5 be completed with the filing date and application serial number already assigned.

line 6 Is used in conjunction with line 5 but only when there have been one or more amendments to the specification or claims. Line 6 is also used when the Examiner requires a new declaration because claims inserted by amendment cover subject matter not originally claimed (37 CFR §1.67).

lines 7-11 Are for PCT (Patent Cooperation Treaty) cases and are used only when you are entering the U.S. National phase (Chapter I or II) based upon a previously filed PCT International application designating the U.S.

line 7 Check this box if this is a PCT National Phase application.

line 8 Insert PCT International application number.

line 9 Insert date of filing of PCT International application.

lines 10-11 Insert the date of all amendments filed in the PCT International application. Such amendments are optional, so this line at times will not be used.

line 12a Is used in the following instances:

- (i) If a single priority is being claimed from a foreign application you need to list only the first-filed application; you do not need to list other countries if all applications were filed within one year of the U.S. filing.
- (ii) If multiple priorities are being claimed, from a plurality of applications filed in one or more countries, you must list the first filed application for each aspect of the invention. Example: if aspect A of the invention was disclosed in an application filed 11 months earlier in country X and aspect B was disclosed 9 months earlier in an application filed in country Y, then the applications in both countries X and Y must be identified. Only the first application for each aspect of the invention needs to be identified provided all applications on that aspect were filed within one year prior to the U.S. filing.
- (iii) If a non-priority application is being filed you must list all applications in all countries where corresponding foreign applications were filed more than one year prior to the U.S. filing. This is so the Examiner can check to see if any of those applications were published or patented early enough to be prior art against the U.S. application.
- (iv) If there are more than two applications to be listed we suggest that you type in on this form only "See attached Schedule A" and then list all of the previous applications on an attached sheet.

line 12b Is used to claim priority under 35 USC §119(c) based on a provisional application filed within one year of the filing of the instant application. More than one provisional application may be identified provided neither was filed more than one year earlier.

line 13 This block is used only in instances where there is a previously filed U.S. non-provisional application which was pending at the time the present application was filed (is being filed). That previous application could be a U.S. non-provisional application or the National Phase of a PCT allocation. In such a case the present application may be entitled to the priority of the previous application's U.S. filing date (and consequently the foreign priority thereof) provided the present application is identified as a continuing application (continuation, divisional or continuation-in-part) of the earlier (parent) application. If the foregoing is applicable, please fill in one line for each such prior application.

line 14 Type the inventor's proper legal name in the order specified, e.g., "John B. JONES" or "J. Bob JONES" if the inventor so prefers. It is not acceptable to use only initials such as "J. B. JONES."

line 15 The inventor's "signature" may be his (or her) usual manner of signing but it is preferable that the inventor simply write his (or her) name in his (or her) own cursive handwriting in the same order as on line 14, e.g., given name, middle initial and Family name.

line 16 Insert the actual date of signature.

line 17 Insert simply the city and state or country, e.g., "Paris, France", of the inventor's residence, not citizenship. No street address or postal code is required on this line.

line 18 Insert the inventor's citizenship. The statement of citizenship (or subject of) is a statutory requirement (35 USC §115). Simply the name of the country of citizenship, e.g., "Japan" is sufficient.

line 19 Insert the inventor's mailing address. The purpose of requiring the post office address is to enable the Patent Office to communicate directly with the inventor if desired, such as in the case of death of the U.S. attorney. It should be the address where the inventor customarily receives his (or her) mail and should include the postal code. If applicable it can be the inventor's business address or address at place of employment.

Applicants are reminded that the U.S. Patent and Trademark Office has very strict requirements as to proper execution of an application. The applicant should make sure that he reviews the declaration, prior to signing to make sure the declaration properly identifies the application and all relevant information; and should review the specification and claims (including drawings, if any) before signing the declaration. Failure to do so will require the filing of a supplemental declaration -- 37 CFR §1.67(c).

Any handwritten changes to the specification, claims or drawings must be in ink personally by all of the inventors prior to signing the declaration and the adjacent left margin must be initialed and dated by all of the inventors, e.g., "JBJ 6-9-91".

Please let us know if there are any questions regarding proper completion of this form. Thank you.

An assignment, a separate document requiring separate signature and dating may be enclosed. Please look for it and sign and date it in the same manner as in

lines 15 and 16 above.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful statements may jeopardize the validity of the application or any patent issuing thereon.

PAGE 2 OF U.S.A. DECLARATION FORM

14a	Typewritten Full Name of Sole or First Inventor	<u>1-10 Koji</u> Given Name Middle Name Family Name		
15a	Inventor's Signature	<u># 村康治 Koji Imura</u>		
16a	Date of Signature	<u>February 14 2001</u> Month Day Year		
17a	Residence	<u>Machida-shi Tokyo JAPAN</u> City State or Province Country		
18a	Citizenship	<u>JAPAN</u>		
19a	Post Office Address (Insert complete mailing address, including country)	<u>4-10-19-1509, Haramachida, Machida-shi, Tokyo 194-0013 JAPAN</u>		
14b	Typewritten Full Name of Sole or First Inventor	Given Name Middle Name Family Name		
15b	Inventor's Signature			
16b	Date of Signature	Month Day Year		
17b	Residence	City State or Province Country		
18b	Citizenship			
19b	Post Office Address (Insert complete mailing address, including country)			
14c	Typewritten Full Name of Sole or First Inventor	Given Name Middle Name Family Name		
15c	Inventor's Signature			
16c	Date of Signature	Month Day Year		
17c	Residence	City State or Province Country		
18c	Citizenship			
19c	Post Office Address (Insert complete mailing address, including country)			
14d	Typewritten Full Name of Sole or First Inventor	Given Name Middle Name Family Name		
15d	Inventor's Signature			
16d	Date of Signature	Month Day Year		
17d	Residence	City State or Province Country		
18d	Citizenship			
19d	Post Office Address (Insert complete mailing address, including country)			

*Note to Inventor: Please sign name on line 15 exactly as it appears in line 14 and insert the actual date of signing on line 16. If there are more than four inventors, please add a copy of this page for identification and signatures for the additional inventors.